

A Highland Strategy for the Mars 2001 Mission: Northwestern Terra Cimmeria.

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Summary: A landing site near 4°N ; 241°W, in northwestern Terra Cimmeria, is proposed as a moderately low elevation site with the potential for sampling and characterizing in situ Noachian material--the most widespread material on the surface of Mars.

Introduction: In earlier considerations of possible martian landing sites, it was argued that any landing site would provide useful science information about the planet [1, 2]. When nothing is known, anything is an advance. We are now beyond that point. Although we are a long way from having comprehensive data base for Mars, we do have some hard knowledge from which to build. What is known is derived from three decades of study, including: imaging from a variety of spacecraft; remote geochemical sensing from orbit; mineralogy and chemistry of Mars meteorites; and rock and soil composition at three landing sites. Future missions must be aimed at specific objectives for maximum value. The 2001 lander has important engineering constraints including restrictions in latitude, elevation, and surface roughness [3]. The 2001 rover will have a limited travel distance from the lander. An acceptable landing site must meet the engineering criteria as well as provide a reasonable science return. The geological questions that can be answered by this mission are primarily those associated with composition and process. Questions concerning absolute age, relative age, and structure are not within the scope of this mission.

Several possible science objectives are acceptable at this stage of exploration, including investigation of highland material, lavas, lake sediments, and crater or basin

ejecta. A landing site on volcanic flow material could provide answers to questions concerning martian differentiation. More than one landing on different volcanic terrains would be preferable to a single landing. A landing of lake sediments would be most interesting and significant in investigation of the possibility of a biotic environment. Crater or basin ejecta could be targeted as samples of buried materials.

Scientific goal: This paper presents arguments for a highland material sampling mission. The objective would be to sample ancient crustal material that constitutes some of the oldest and most widespread material on the planet. Chemical and mineralogical analysis could address questions concerning development of the early crust of the planet and whether it is gravitationally segregated as in a magma ocean or by voluminous lava outpouring. A landing site far removed from the Sojourner site could test the diversity of crustal materials.

Ancient crustal material may be sampled in one of three ways: (1) direct landing in the highlands; (2) sampling alluvial materials derived from highland regions; or (3) sampling crater rim materials ejected from a highland site. Of these possibilities, a landing on highland materials at an acceptable low elevation is preferred as the best chance to avoid the ambiguity of distant source areas.

Proposed site: The proposed site is located in the vicinity of 4°N; 241°W (Fig. 1). Movement of the landing point by several degrees will not affect the scientific return of the mission. The site is in the highlands of northwestern Terra Cimmeria, between Elysium Planitia and Hesperia Planum.

Northwestern Terra Cimmeria: R.A. De Hon

The materials of the region are cratered plateau materials that are highly dissected by small channels.

Site Characteristics:

Location	4_N; 241_W
DTM elevation	2.0 to 2.5 km
MOLA elevation	1 to 2 km
Geologic unit	Npld
Rock abundance	<10%
Fine thermal inertia ($\text{cal cm}^{-2} \text{s}^{-0.5} \text{K}^{-1}$)	$6-8 \times 10^{-3}$
Bulk thermal inertia ($\text{cal cm}^{-2} \text{s}^{-0.5} \text{K}^{-1}$)	$6-8 \times 10^{-3}$
Delay doppler radar available	None
Viking imaging	<50 m/px
MOC imaging	?

Discussion. This site is on the upper limit of elevation which could affect the safety of the landing maneuver. This site, in a region of Noachian material, need not be tightly targeted. Movement of the aim point by several degrees will not greatly affect the results. Noachian dissected plateau material (Unit Npld) is ancient terrain modified by running water [4]. Material

may, therefore, be redistributed from its original location and may suffer significant physical and chemical alteration. This unit, at lander scale of observation, can be expected to be quite heterogeneous in composition. Post-Noachian eolian or fluvial materials may be present. However, large rocks can be expected to retain their geochemical and mineralogical character. Comparison of analysis of rock and fine-grained material with those of previous landing sites would provide insight into the homogeneity or diversity of the martian crust and would confirm or reject the presence of a ubiquitous dust component of martian surface materials.

References: [1] De Hon, R.A., 1994, *Mars Pathfinder Landing Site Workshop*, LPI Technical Report No. 94-04, 24-25. [2] De Hon, R.A., 1998, *Mars 2001 Landing Site Workshop*, NASA Ames, Jan. 26-27. [3] Golombek, M. and others, 1999, *LPSC XXX*, Abs. #1383. [4] Greeley, R. and Guest, J.E., 1987, *U.S. Geol. Surv. Misc. Inves. Series Map I-1802-B*.



Figure 1. Viking Orbiter mosaic of northwestern Terra Cimmeria. Approximate location of the proposed landing site is marked by an X at 4_N and 241_W. Mosaic is 450 km across.